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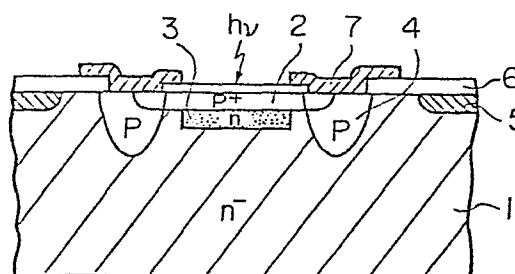
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(54) **Avalanche photodiode.**

(57) A practical germanium avalanche photodiode (Ge APD) for use with 1.5  $\mu\text{m}$  band light with which a silica optical fibre has a minimum transmission loss is provided by forming a reach-through type Ge APD having a  $\text{P}^+\text{N}^-\text{N}^+$  structure. Typically the photodiode includes an  $\text{N}^-$  type substrate 1 with a  $\text{P}^+$  type region 2 in the substrate and adjacent its surface with an N type region 3 interposed between the  $\text{P}^+$  type region 2 and the  $\text{N}^-$  type region 1. Preferably the  $\text{P}^+$  type region 2 and the N type region 3 are surrounded by a P type region 4 forming a guard ring. It is further preferred that the doping concentration of the  $\text{N}^-$  type region 1 is below  $1 \times 10^{15} \text{cm}^{-3}$  and the doping of the N type region 3 is between  $1 \times 10^{16}$  and  $1 \times 10^{17} \text{cm}^{-3}$ .

*Fig. 1*





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## EUROPEAN SEARCH REPORT

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EP 82 30 5104

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. <sup>3</sup> )
X	FR-A-2 331 884 (PHILIPS GLOEILAMPENFABRIEKEN) * Page 1, line 1 - page 2, line 32; page 4, lines 22-35; page 5, line 34 - page 6, line 9; page 6, line 24 - page 7, line 7; page 7, lines 11-22; page 8, lines 22-27; page 9, lines 23-39 *	1-3,5	H 01 L 31/10
A	--- APPLIED PHYSICS LETTERS, vol. 34, no. 12, June 1979, pages 866-868, New York, USA T. KANEDA et al.: "Shallow-junction p+-n germanium avalanche photodiodes (APD's)" * Whole article *		
A	--- PATENTS ABSTRACTS OF JAPAN, vol. 5, no. 117(E-67)(789), 28th July 1981 & JP - A - 56 55080 (NIPPON DENSHIN DENWA KOSHA) 15-05-1981 * Abstract *	6	TECHNICAL FIELDS SEARCHED (Int. Cl. <sup>3</sup> )  H 01 L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 18-05-1984	Examiner SCHUERMANS N.F.G.
<b>CATEGORY OF CITED DOCUMENTS</b>			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons  & : member of the same patent family, corresponding document	